

WHAT IS CLAIMED IS:

1. A semiconductor device comprising:
 - a semiconductor substrate;
 - a capacitor lower electrode having a vertical portion extending substantially perpendicularly to a main surface of said semiconductor substrate;
 - 5 a capacitor dielectric film covering a surface of said vertical portion;
 - a capacitor upper electrode covering a surface of said capacitor dielectric film,
 - 10 a film thickness of a portion of said capacitor dielectric film formed on top of said vertical portion being greater than a film thickness of a portion of said capacitor dielectric film formed on a side of said vertical portion.
2. The semiconductor device of claim 1, wherein said capacitor dielectric film has a two-layer structure for the portion formed on top of said vertical portion.
3. The semiconductor device of claim 2, wherein said two-layer structure is formed of two types of insulation film different in composition.
4. A method for manufacturing a semiconductor device, comprising the steps of:
 - above a semiconductor substrate, forming a film to be a capacitor lower electrode having a vertical portion extending perpendicularly to a
 - 5 main surface of said semiconductor substrate;
 - forming a film to be a capacitor dielectric film to cover a surface of said vertical portion;
 - adhering an additional dielectric film on a surface of said film to be said capacitor dielectric film above said vertical portion by sputtering or
 - 10 plasma chemical vapor deposition of a dielectric from above said film to be said capacitor dielectric film; and
 - forming a film to be a capacitor top electrode to cover a surface of

said film to be said capacitor dielectric film and a surface of said additional dielectric film.

5. A method for manufacturing a semiconductor device, comprising the steps of:

above a semiconductor substrate, forming a film to be a capacitor lower electrode made of ruthenium having a vertical portion extending substantially perpendicularly to a main surface of the semiconductor substrate;

annealing said film to be a capacitor lower electrode in a reducing environment at a temperature ranging from 500 to 950°C under a pressure ranging from 1 Torr to atmospheric pressure for at least one minute;

forming a film to be a capacitor dielectric film to cover a surface of said capacitor lower electrode annealed; and

forming a film to be a capacitor upper electrode to cover a surface of said film to be said capacitor dielectric film.

6. A method for manufacturing a semiconductor device, comprising the steps of:

forming an interlayer insulation film above a semiconductor substrate;

making a hole penetrating said interlayer insulation film from top to bottom;

forming a film to be a capacitor lower electrode of ruthenium on a side of said hole by metal organic chemical vapor deposition;

removing said interlayer insulation film to leave said film to be said capacitor bottom electrode;

annealing said film to be said capacitor bottom electrode in a reducing environment at a temperature ranging from 650 to 950°C under a pressure ranging from 1 Torr to atmospheric temperature for at least one minute;

forming a film to be a capacitor dielectric film to cover a surface of said film annealed to be said capacitor lower electrode; and

forming a film to be a capacitor top electrode to cover a surface of said film to be said capacitor dielectric film.